

# Surrogate

- to elect in place of another;  
to substitute in place of.
- deputy; delegate.
- Person appointed as deputy of an ecclesiastic judge, most commonly a bishop or his chancellor.
- in some states a competent probate judge in charge of probating wills, administering estates, etc.

Examples of

Surrogates that  
we heard:

A is surrogate for B

(d,p) to unbound states

$\sigma_n$

ANF

(p,d), etc.

(d,p) time reverse (p,d)

branching ratio

(p,g)

D( $^{132}\text{Sn}$ ,p)

(d,p)

"inversionum"

(t,pf), etc.

$\sigma$  (n,fission)

( $^3\text{He}$ ,dXn)

(n, + n)

But where does it stop?

Coulomb Excitation

$T_{\frac{1}{2}}, \Gamma_{\delta}$

(d, p)

to bound states.

" $\Gamma_n$ ",  $\delta_n^2$ , S

watch

position of Sun

⋮

⋮

Most of our physical measurements  
are surrogates!

A surrogate technique has to

1. Make it plausible, by calculation & measurement that it is an appropriate surrogate.

Example: Is the distribution of spins in the intended system from ( ${}^3\text{He,d}$ ) the same as from neutrons at the same excitation energy?

a) study compound + direct component by experiment;

b) estimate spin distributions by calculation from simple reaction theory

c) test this with  $\gamma$ -ray measurement

2. Establish benchmark experiments where the answer is known (say ~10 cases)

Example ( $t, p f$ ) - Younes

## Gratuitous observation:

The stockpile stewardship community has perhaps been a little ~~too~~ isolated from the rest of N.P.

### Examples:

1.)  $(p, p')$  etc. show Giant resonances:  $0^+_1, 1^-_1, 2^+_2$  iso vector + isoscalar that exhaust the particle-hole sum rule. Connection to  $(n, n')$  is obvious - yet no attempt to fit both data sets with codes.

2.) Quasi-free "knockout" reactions, e.g.  $(p, 2p)$ ,  $(p, pn)$  must have analogs in  $(n, 2n)$  direct reactions at higher energies.

etc.

Come join the rest of us.  
(meetings, etc.)

Why not n-adding ( $d,p$ )?

better surrogate

$\ell$ -value distribution more like n

e.g. 30 MeV ( $d,p$ ) with 15 MeV p in  
coincidence will be close to  
14 MeV n in  $\ell$ -transfer and  
in "pre-compound" effects.

## Another Observation:

A new generation is getting involved. This is good and healthy: an opportunity for fresh perspectives and closer links to other fields.

## CONCLUSIONS:

"SURROGATE" techniques abound in physics, nuclear physics, nucl. astrophys. Much that is important to be done!

Some of the stated needs of stockpile st. can be met in the near future with a focused, high-quality effort based on the best understanding of nuclei and reactions.

Excellent preparation for RIA where such measurements can be extended farther into the unknown.

Thanks for a good workshop!